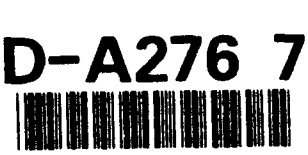

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Changing the Acquisition Process for a New World Order

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ABSTRACT

The Chinese blessing (or curse?), "May you live in interesting times", is certainly applicable in today's world. The crumbling of the Berlin wall and subsequent end of the Cold War prompted former President Bush to proclaim a "new world order" had arrived. Unfortunately, the "new world order" is more a world of disorder. This paper explores the ramifications of these profound changes to the Department of Defense's acquisition process. The changes are a result of the shift in national military strategy from reliance on forces-in-being to a reliance on military potential. The following changes are discussed in the paper:

1) A More Flexible Acquisition Process
2) Fewer New Starts/More Existing Program Upgrades
3) Decrease in the Number of Production Programs
4) Increased Focus on the Ability to Reconstitute
5) Increased Emphasis on Four "...ilities"
6) Increased Reliance on Prototyping

Because of its importance, the subject of prototyping is examined in detail. But a prototype in and of itself does not represent a warfighting capability. A strategy must be devised to take a system that has been developed through low rate production and then "shelved", through production restart. The following recommendations are then discussed:

1) Design Producibility In From the Start
2) Increase Manufacturing Technology and Process Investment
3) Develop "Smart" Shutdown Technologies
4) Develop a Long Lead Procurement Strategy
5) Increase Reliance on Government/Commercial Integration
6) Increase Use of Lean Production Techniques

If the United States is to remain the leader of the "new world order", the DOD acquisition process must change to adjust to the "interesting times" in which we live.

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CHANGING THE ACQUISITION PROCESS

FOR A NEW WORLD ORDER

Three weeks after the Iraqi invasion of Kuwait, former President Bush coined the term "new world order". Ever since that time people have been grappling with what it really means. President Bush offered his definition in April 1991 when he said the Persian Gulf War was about "more than one small country; it is a big idea; a new world order," with "new ways of working with other nations...peaceful settlement of disputes, solidarity against aggression, reduced and controlled arsenals and just treatment of all peoples." Regardless of what the post Cold War era is called, the world has undergone cataclysmic change in the last three years. The crumbling of the Berlin wall, the fall of the Soviet empire and the liberation of Kuwait are but a few of the many events that have shaken the world. This change is causing a rethinking of our foreign and domestic policy as it relates to the three "tools" the government has at its disposal: military, economic and political. One aspect of the military tool that needs examination in light of the changed world we live in is the acquisition process. While numerous past studies have focussed on improving the process, given a stable, bipolar world, we now need to step back and scrutinize the process based on the "new world order". Is the current acquisition process still

relevant in this changed world? What changes need to be made to ensure it is relevant? These are two key questions I will address in the pages to follow.

To adequately cover the topic, I have divided the paper into five major sections. Before any changes to the acquisition process can be addressed, the first step is to discuss the characteristics of the so called "new world order". Once the characteristics have been defined, the next section will examine the main consequence of the "new world order" from a DOD perspective: declining defense budgets and the subsequent reliance on military potential. The stage will then be set to launch into an analysis of what changes need to be made in the acquisition process to respond to the "new world order". The fourth section of the paper will delve into one of the more important areas of required change: prototyping. Finally, the last section will address the timely subject of transitioning a new weapon system to production after the initial low rate production line has been shut down. Let's begin then by examining this new world we live in.

THE NEW WORLD ORDER...OR DISORDER

As mentioned earlier, there is no consensus on what the term "new world order" really means. Regardless of the term used to describe the post Cold War era, the concept is that the demise of the Soviet empire and East-West hostilities has fundamentally changed the way nations of the world relate. This change is

summed up nicely by Joseph Nye Jr. in the following analogy:

> The distribution of power in world politics has become like a layer cake. The top military layer is largely unipolar, for there is no other military power comparable to the United States. The economic middle layer is tripolar and has been for two decades. The bottom layer of transnational interdependence shows a diffusion of power (Nye 88).

I believe there are four basic characteristics of the "new world order" that deserve further discussion: Unipolar world, Regional instabilities, Economic tensions and Multilateral solutions to world problems.

Unipolar World: One Remaining Superpower

Perhaps the most fundamental change in world relationships is that the collapse of the Soviet Union has left the United States as the remaining superpower. No other nation has a more "diversified portfolio of power resources" (Nye 88). While there are other great powers in the world today (Russia, Japan, China and the European Community), each has its own unique weaknesses that prevent it from matching the rich mix of powers the U.S. possesses. But does this superpower status mean that American interests will now dominate world affairs? The answer is no--primarily because of the relative decline in value of military power vice economic power. Henry Kissinger makes this point when he writes:

> America remains militarily the strongest nation, but the spread of technology and reduced military budgets make this a declining asset...Economic vitality will become as important an element of national power as military strength. Power will be the nexus of political, military and economic assets (Kissinger A21).

The U.S. challenge in the "new world order" then, will be to balance the traditional extremes of foreign policy--from complete isolationism to overextension.

Regional Instabilities: The Unknown Threat

The end of the Cold War is a "good news - bad news" story. The good news is obvious--the arch enemy of the U.S. dissolved before our very eyes and the risk of a major global war went from probable to unlikely. Ironically, the bad news is that the stability the old world order provided is now gone. The bi-polar world smothered ethnic unrest in Soviet client states and focussed the free world against a common enemy. The unipolar world has now unleashed pent up rivalries in three areas: ethnic, religious and nationalistic. Regional instabilities will be the battleground of world affairs for the next decade. The proliferation of nuclear, biological and chemical weapons in these regions adds an ominous twist to the consequences of instability. While the potential for military confrontation is real, the primary battles in this "new world order" may be fought in the economic arena. The following section will discuss the main players in this economic "war".

Economic Tensions - 3 Superpowers

The world is truly getting smaller. We live in an age of an increasing dependence on the global market for our economic well being. Transnational corporations are becoming the rule rather than the exception. In this environment, three economic giants have already emerged: the U.S., the European Community and

Japan. The potential exists for China to join this elite group by the turn of the century as economic reform sweeps across that vast nation. The "new world order" will see increasing tension between these economic superpowers as they jockey for market share in the world market. Carried to its extreme, this market share will ultimately determine the standard of living each country enjoys.

Multilateral Solutions to World Problems

The fall of the Soviet Empire and the subsequent cooperation with Washington has thrust the United Nations into a new era. This was vividly demonstrated with Security Council Resolutions 687 and 688 where Russia sided with the United States in voting to expel Saddam Hussein from Kuwait. A more recent example is the peacemaking operation in Somalia where the U.N. is in the process of assuming the leadership mantle from the U.S.. While the jury is still out on how effective the U.N. will be in this new role as world policeman, it has demonstrated it now has the resolve to invoke U.N. Charter, Chapter 7, peacemaking provisions to ensure its objectives are met. Thomas Pickering, U.S. ambassador to the United Nations, defined the "new world order" as "using the United Nations and Security Council in regional disputes" and said this is a part of a "long progression of change" that began before the gulf war and accelerated in its wake (Oberdorfer A36). Because of its unique position as the sole remaining superpower, the U.S. must be cautious not to abuse its power in the eyes of the world. It will do this in the

future by increasingly relying on the United Nations to legitimize its actions. In addition, look for the United Nations to expand its reasons for multilateral intervention by invoking chapter seven of the United Nations charter "if it determines that internal violence or development of weapons of mass destruction are likely to spill over into a more general threat to the peace in a region" (Nye 92).

This section of the paper has explored the definition of the "new world order". Four major characteristics were discussed: 1) Unipolar World 2) Regional Instabilities 3) Economic Tensions and 4) Multilateral Solutions. The major consequence of the "new world order" that will motivate change in the current acquisition process is a sharply reduced defense budget. As the American people look for a peace dividend, the defense budget has become a prime target. The next section will discuss that subject and its impact on military strategy of the future.

DECLINING DEFENSE BUDGET

One of the many ironies of the key role DOD played in winning the Cold War is that its reward for making the world safer is a significant budget reduction. Former President Bush had proposed a $43 billion reduction from FY 93-FY 97 and President Clinton is proposing an additional cut of $100 billion. This will have a dramatic affect on all aspects of the military--the acquisition process included. Before addressing some of the

specifics of the changes this will cause in the acquisition process, I believe it is important to first view the changes from a strategic perspective.

Paradigm Lost

The "new world order" and subsequent defense budget cuts will de-emphasize forces and equipment in being and put increased emphasis on military potential. This is an outgrowth of the reduced threat and the inter-related increased warning and preparation time expected before an adversary could become powerful enough to challenge the U.S. in a global war context. In a time of uncertainty, with no bonafide threat, the U.S. military must retain an adequate capability to respond instantly to potential regional threats (ie. with the base force), while at the same time maintaining a flexible reconstitution capability to rapidly build the force structure should a larger threat loom on the horizon. Ted Gold and Rich Wagner neatly characterize this shift from forces-in-being to military potential in three paradigms: attack, mobilization and rearmament (Gold 6). The attack paradigm is characterized by large standing forces poised to attack or defend in days or weeks. It, of course, is the paradigm we have operated under for the past forty years. But the move is already on toward the mobilization paradigm which will have smaller standing forces with several months to a year to prepare for very large scale offensive action. As the review of the National Security Emergency Preparedness Mobilization Policy put it, "As standing forces decline, the balance of power

will be measured increasingly in terms of 'mobilizable capacity'" (ICAF 45). The future may go even a step further into a rearmament paradigm with even fewer standing forces and a time span of several years before a capability to mount a sizeable offensive military operation would exist. It is in the context of the mobilization or rearmament paradigm that the new acquisition process must operate. Below I will discuss what specific changes to the acquisition process must be made to accommodate this new paradigm.

THE NEW ACQUISITION ORDER

We have now reviewed the characteristics of the "new world order" and the military consequences of a substantially reduced defense budget. But what does all this mean to the acquisition process? I will briefly list the required changes to the process below. Any one of them could be the subject of a research paper in and of itself, but I will focus on one of the most important: the concept of prototyping.

A More Flexible Acquisition Process

The current acquisition process as described in the DOD 5000 series of regulations is very "pipeline" oriented. That is to say, once a system enters the front end of the process (MS I) it normally can be expected to exit out the other end (production) and eventually be deployed. This model is no longer compatible with the "new world order" environment. An Institute for Defense Analyses (IDA) report on this subject states, "We conclude that

mission uncertainty, budget limitations and the need for system and force flexibility, require a flexible acquisition strategy" (IDA 3). The acquisition process of the future must be adaptable enough to accommodate some programs in "hover" awaiting technology infusion, some programs skipping steps in the "pipeline", some programs in continuous lean production mode and other programs "on-the-shelf" awaiting potential production restart. Because this concept forms the foundation for much of the required acquisition reform, different aspects of it are scattered throughout the remainder of the paper.

Increased Focus On Maintaining Technological Superiority

Since military potential will become the major tenant of military strategy for the next decade, the U.S. must be poised to field the most technologically advanced weapons in the world when called on to do so. Operation Desert Storm vividly demonstrated the "force multiplier" effect of our technological superiority. This will require increased funding for both Science and Technology (categories 6.1,6.2,6.3A) and Research and Development (categories 6.3B,6.4,6.5) budget lines. The culture in the defense industry must change from one of "buy-in" early and recoup profits during production to making a fair profit during the early development phases of a program since production will not be guaranteed.

Fewer System New Starts/More Existing Program Upgrades

Constrained defense dollars coupled with the lack of a major threat will act as a catalyst to keep existing weapon platforms

longer, upgrading as required. While serving as the Chairman of the House Armed Services Committee (HASC), Secretary of Defense Les Aspin made "Selective Upgrades" one of his four pillars of industrial base reform. He argues that:

> The advantages to performing such upgrades are threefold: upgrading allows us to modernize systems where modernization through production is no longer feasible; upgrading requires production capacity that could also contribute to a surge potential in an emergency; and perhaps most importantly, upgrading sustains a base for production of future systems (Aspin 13).

Decrease In Number of Production Programs

The renewed emphasis on the earlier phases of the acquisition cycle (S&T and R&D) brought about by the priority of military potential will of necessity reduce the amount of money available for the procurement of systems. Secretary Aspin has proposed the following criteria for determining when new programs should transition to production: 1) the technology works; 2) it is required by the development of the threat; 3) it represents a breakthrough that would alter battlefield operations (Aspin 15).

Increased Focus On the Ability to Reconstitute Forces and Equipment

A dichotomy should now be apparent. While on one hand there will be a decrease in the number of production programs, on the other there will be an increased emphasis on the ability to reconstitute quickly. This dilemma has been the subject of much on-going debate. Several solutions have been offered: increased defense/commercial manufacturing integration, use of flexible

manufacturing systems, increased manufacturing process funding, continuation of low rate production and government subsidization of the Defense Industrial Base. This topic will be addressed in more detail later in the paper.

Increased Emphasis on Four "...ilities": Transportability, Producibility, Modularity and Interoperability

A key aspect of the new military strategy calls for the ability to project forces quickly into any theater around the world. As we learned in Desert Shield/Storm, many of our weapon systems are not designed for transportability and consumed huge amounts of airlift and sealift capability. The weapon systems of the future must be designed to minimize lift requirements. Because of the importance of reconstitution, new weapon system designs must also stress producibility. If the system cannot be manufactured in a reasonable time, it will have no value because the war will be over before it rolls off the line. Modularity and the ease of modifying systems will also come into play due to the unknown nature of the threat. Systems will be forced to be designed with growth in mind or risk being useless against an evolving threat. Finally, due to the fact that most future wars will be fought in a coalition, a high premium will be placed on interoperability with foreign forces.

Increased Reliance On Prototyping

Prototyping offers an attractive option to solving many of the new acquisition process ills. The rest of the paper will examine this important concept in detail.

PROTOTYPING

What Is It?

If there is one universal point of agreement in acquisition reform, it is the importance of prototyping in the acquisition process. Webster defines prototype as "the first thing or being of its kind; original; model; pattern; archetype". Part of the confusion surrounding prototyping is the vast variety of prototypes employed or proposed in the last several years. The Office of Technology Assessment (OTA) has defined a prototyping spectrum that relates the different types of prototypes to phases in the acquisition process (see Table 1 in the appendix). For simplicity sake, prototyping can be broken down into two categories: Conventional and Unconventional.

Conventional: Conventional uses of prototyping include Demonstration and Validation Phase Competitive prototyping and Engineering and Manufacturing Development (formerly called Full Scale Engineering Development) pre-production prototyping. The objective of competitive prototyping in Dem/Val is to compete basic system design to aid in the downselect to a single contractor in EMD. The classic example of this type of prototyping is aircraft procurement with the most recent example being the fly-off between the Lockheed YF-22 and Northrop YF-23. The purpose of pre-production prototyping is entirely different. Its goal is to build developmental units that will ease the difficult transition from hand-built EMD units to low (and eventually high) rate production units. These units typically

include all "...ility" upgrades from EMD (reliability, maintainability, producibility, etc.) and serve as a test tool to wring out soft production tooling. Almost all major acquisition programs in the last ten years have had some sort of prototype to accomplish this objective.

Unconventional: More recently, several "unconventional" prototyping concepts have been introduced. I was personally involved in developing the acquisition strategy for a much needed Anti-Tactical Ballistic Missile (ATBM) defense system that included the concept of a fieldable prototype. The idea behind the prototyping concept for the Theater High Altitude Area Defense (THAAD) system, besides the normal prototyping advantages, was to provide a "gapfiller" capability until the full-up system could be produced and fielded 10-12 years down the road. The concept was initially opposed by the USD(A), but after seven months of discussion, finally approved by the Defense Acquisition Board in January 1992. The Office of the Secretary of Defense (OSD) has recently endorsed another concept called Advanced Technology Demonstrators (ATDs). An ATD is a program "focussed on validating the maturity and utility of advanced technologies and will, therefore, reduce performance, cost and schedule risks in future acquisition programs" (Yockey 1-2). The ATD differs from conventional prototyping in that it is developed pre-formal acquisition process (ie. Milestone I) by the Science and Technology community. Refer to the Appendix, Table 2, for a chart highlighting the major differences between an acquisition

program and an ATD. It is outside the scope of this paper to analyze the various pro's and con's of each of the types of prototyping. Suffice it to say that in the uncertainty and volatility of the "new world order", a wide variety of prototyping strategies need to be available for implementation as the need arises.

Why Is It Important?

As mentioned previously, prototyping is probably the most agreed upon acquisition reform to come along in quite some time. Refer to the Appendix, Table 3, for a detailed listing of excerpts from eight different prominent sources that extol the virtues of prototyping. A summary listing of the benefits is provided below:

1) Allows early assessment of technological maturity and applicability to military requirements
2) Excellent performance, cost and schedule risk reduction tool
3) Affords maximum flexibility in the acquisition process: program can continue as conceived, "hover", or "roll-in" new technologies
4) Gives user opportunity to conduct early operational assessment
5) Allows focus on producibility and manufacturing process issues early in system life cycle
6) Serves as deterrent to potential aggressors ("Long Shadow" effect, see Gold and Wagner p.3)
7) Improves cost estimating process for future phases of acquisition cycle
8) In special situations, can provide interim warfighting capability until objective system can be fielded (ie. role of Joint Stars in Persian Gulf War)

Now that the advantages of prototyping have been established, the next logical question is what type of acquisition strategy should be used to move into production and

deploy the system in a timely manner? This question is probably as contentious as the basic concept of prototyping is accepted. The next section will explore this important and timely issue.

TRANSITIONING TO DEPLOYMENT

This section assumes that a prototype has been developed, tested and matured to the point where a decision to enter production is at hand, but the threat is such that immediate deployment is not required. The question I will try to address in the context of the "new world order" is: What is the best way to implement the production strategy for this weapon system? Many factors weigh on this decision: projected need date of the weapon system based on the threat, industrial base ramifications, potential for further technology infusion and cost. Using information obtained from RAND on restarting production as a springboard, the following table documents the production options available for both existing systems and the focus of this paper, new systems :

PRODUCTION OPTIONS

	Existing Systems	New Systems
No Production	N/A	Stop work on program after development and test. If required to produce in future, work out prod. transition problems at that time.
Restart production	Stop production when program need satisfied. Perform "smart" shutdown. Restart production in future if needed	Develop and test new system, produce only enough to prove production process. Preserve low-rate capability. Restart production, expand rate as needed in future.
Sustained low-rate production	Continue production at low rate to maintain active production capability, permitting rapid surge to higher rate if needed	Establish initial production line for efficient operation a low-rate.
High-rate production with storage	Extend normal production, store excess items until needed	After normal production run, produce at efficient (high) rate to cover future requirements, store quantities excess to present requirement until needed.

Analysis of Options

Analysis of these options rests primarily on two factors: cost (because of declining defense budgets) and risk of not having capability ready to deploy when needed (because of the uncertain threat). The "No Production" and "High-Rate Production With Storage" options can be eliminated almost immediately. Certainly one of the most painful lessons learned in acquisition is that the transition between development and production is one of the toughest steps in the process. The "No Production" option, while the cheapest in the short term, would induce unacceptable risk in the ability to produce the system in a timely manner. Conversely, the "High-Rate Production With Storage" option would have the lowest schedule risk, but would carry a prohibitive cost penalty. In today's fiscal environment, Congress does not have the luxury of stockpiling weapon systems of unknown future need. That leaves two remaining options to consider: Restart Production or Sustained Low Rate Production. Choosing between these options becomes very difficult and can only be made on a case-by-case basis. It is also important to note that in reality, because of industrial base concerns, there will always be a mix of production strategies in being. Secretary of Defense Les Aspin, when serving as the HASC chairman, proposed the following mix (Aspin 12-18):

> No single prescription, be it prototyping, conversion or any other remedy, can achieve all of these ends. A comprehensive strategy for directing resources in a way that maintains the needed industrial base is required. Below are four elements comprising such a strategy:

I. Selective Upgrading
II. Selective Low-Rate Procurements
III. Rollover-Plus
IV. Silver Bullet Procurements

Since the strategy of sustained low rate production is fairly well understood and has actually been implemented on both old (ie. F-16) and new (ie. F-117 reached max rate of 8 A/C per year) programs, the remainder of the paper will tackle the issue of how to effectively restart production of a new system that has only experienced limited low rate production. Please note that I am not suggesting that raw technology can be taken "off-the shelf" and immediately turned into an efficient (or even inefficient!) production operation. What I am suggesting is that with proper planning, a new system can be produced in very small initial low rate production quantities, put "on-the-shelf", and then be resurrected in a timely fashion to high rate production. I would argue that this capability must be developed--if not today within the near future. It is the only cost effective method, in an era of declining budgets, to balance technological superiority with fielding only those systems that are absolutely required to protect our national security. Addressing this very issue, OTA states:

> [with a prototyping strategy]...the total cost would be considerably less than the alternative of maintaining a warm production base for most military items, which is simply not feasible in the current budgetary or strategic environment (U.S. Congress, Building Future Security 74).

The following section will posit several practical ideas for making such a transition possible.

RESTARTING PRODUCTION: STEPS TOWARD REALITY

The key principle around which the entire concept of restarting production is built is that it must be done in a timely fashion. Anyone would agree that given enough time and money, any program could be successfully transitioned to production. But in the "new world order", the luxury of time does not exist. If a weapon system cannot be turned into a deployable system quickly, it loses its utility to the warfighter. While the amount of warning time for reconstitution has been disputed, I will define "timely" as 6-18 months from go-ahead until the first unit rolls off the line (add approximately 12 additional months before any kind of significant monthly rate can be achieved). This is acknowledgedly ambitious, but I believe it is a realistic requirement based on the uncertainty we see in the world today. While DOD has opted to plan reconstitution on the basis of a longer rather than shorter term crisis scenario, in Defense Reconstitution, the Congressional Research Service points out:

> Historical precedents suggest that the too frequent inability to clearly identify near-term threats may not justify neglecting near-term reconstitution capabilities (CRS 4).

I will term this concept Flexible, Agile and Streamlined Transition (FAST). The elements of FAST will be described below. In many cases they are generic concepts that can be applied equally as well in solving basic reconstitution shortfalls.

Design Producibility In From The Start

Probably the most significant change that could be made to ensure a smooth transition in restart would be to begin with a production "friendly" design. Some characteristics of a production "friendly" design include: minimal number of long lead components; modular designs that allow for easy assembly, rework and repair; minimal part count; use of manufacturing processes with high yields; minimal number of operations requiring skilled technicians; accessible test points for troubleshooting; designs that allow automated testing; and maximum use of commercial components. In the "new world order" acquisition system, the old axiom that the program manager has to worry about cost, schedule and performance must be modified to include producibility. DOD must be willing to trade-off performance for producibility in the new environment. In this era of military potential, a weapon system with superb performance is useless if it can't be reconstituted in time to affect the outcome of the war. The major way to implement this producibility emphasis into the development process is through the practice of concurrent engineering. Concurrent engineering is the term used to describe a concept of integrating both design and manufacturing engineers in the initial design of the product. The manufacturing engineers should have as much "clout" in the design as the design engineer. While concurrent engineering has received a lot of lip service in the defense contractor arena, a fundamental change in corporate culture must take place for it to

really be effective. An informal pecking order among engineers exists in most defense contractor's plants: design, manufacturing, quality and logistics. All must be put on equal ground. DOD must find ways to incentivize defense contractors to pay attention to this critical area.

Increase Manufacturing Technology and Process Investment

Our nation has a tradition of being excellent in innovation and poor in implementation of new ideas. The MIT commission in the book Made In America states:

> In a recent comparative study of industrial research and development in Japan and the U.S., Edwin Mansfield found that U.S. firms are still devoting only a third of their R&D expenditures to the improvement of process technology; the other two-thirds is allocated to the development of new and improved products. In Japan these proportions are reversed (72).

This is yet another paradigm that must be broken. Manufacturing technology and process investment has been grossly underfunded for many years. One gauge of this is DOD funding for the Manufacturing Technology (MANTECH) program. The MANTECH program was created in 1977 to fund promising areas of manufacturing improvement. A recent report on the U.S. industrial base by the Office of Technology Assessment states, "In general, support for the MANTECH program is stronger from Congress than it is from DOD. For example, for the 1991 budget, Congress added $150 million to DOD's $265 million request" (U.S. Congress, Redesigning Defense 53). Even at $415 million a year, this amount is a drop in the bucket compared to the approximately $40 billion a year spent on R&DTE. If FAST is ever going to work, it

will require a breakthrough in the manufacturing technology/process area. The same level of commitment that made this nation the greatest idea generator in the world must be applied to making the nation the best implementor in the world.

Develop "Smart" Shutdown Technologies

RAND has recently studied the issue of production restart possibilities and looked at what is involved in a "smart" production shutdown. While their work addresses several different shutdown scenarios, the one of interest here is the case of a new system that has been developed and brought through a limited low rate production run but for various reasons a decision is made not to enter rate production. The following list, based on the RAND work and some of my own thoughts, summarizes the steps required in a "smart" shutdown to maximize the probability of success if the decision is subsequently made to restart the production line:

1) All documentation must be preserved. Government must ensure maximum use of CAD/CAM and other computerized systems to aid in preservation and configuration control
2) Engineering test and development hardware must be preserved
3) Manufacturing tools, fixtures and processes must be preserved
4) Detailed photographs and videotapes of all manufacturing operations must be produced
5) Extensive financial data and records must be kept
6) Emphasis must be placed on all subcontractors and vendors to ensure capture of all pertinent items (latest trends show 60-80% of work will be distributed to subs and vendors)
7) Parts list must be scrubbed to ensure market availability in the future
8) Personnel roster of all key employees (management, engineering, manufacturing, etc.) must be maintained

(NOTE: Refer to Appendix, Table 4, for detailed list of actions)

While this seems to be a very rigorous set of requirements,

"...it appears that a rather robust program of preparing for future production restart should be relatively inexpensive" (RAND). Let me summarize this section with two closing points. First, the key to successful restart is to try to capture all of the little "gotchas" and lessons learned from the initial run of the system. While in the past this may have been impossible, in today's Total Quality Management dominated world, Statistical Process Control requires the process to be documented, studied and analyzed to excruciating detail. This should lead to the "do-ability" of preserving this valuable information. Second, the shutdown package will only be as good as the maturity of the system (both design and manufacturing) at time of shutdown. A great deal of time and effort must be placed on producibility and manufacturing processes in the development phase to ensure all major issues are discovered and addressed prior to "mothballing". Undoubtedly there will be a new set of "unknown unknowns" pop up as the system is restarted and brought into high rate production. The key to success is to eliminate, or at least minimize, any known problems with the system prior to shutdown.

Develop A Long Lead Procurement Strategy

No matter how producible the design, no matter how refined the processes, no matter how good a job of shutdown was accomplished, the fact of the matter remains that parts are required to build any system. The reconstitution challenge to deliver the first unit off the line 6-18 months from go-ahead creates a difficult situation for long lead procurement. Many

items have long lead times greater than six months (ie. connectors, custom microprocessors, certain castings or hog-outs, etc.). There are no easy answers, but the following "algorithm" is offered to address the problem:

1) Prior to shutdown, the parts list must be scrubbed for potential long lead items
2) If possible, alternative parts with shorter lead times should be specified
3) Available commercial substitutes (primarily at the component level) should be exploited where applicable
4) If none of the above works, an analysis should be performed to determine the number of units needed in stockpile to allow the restarted production line to roll unimpeded until time allows the parts to be supplied. The identified stockpile must be purchased to protect the schedule in the event of restart.

At this point many would argue the cost feasibility of such an approach. Certainly a cost/risk trade-off would have to be performed to actually assess the soundness of the shutdown decision. If stockpiling long lead items became too expensive, one alternative would be to simply slip the restart schedule and subsequent Initial Operational Capability (IOC) of the system. Whether or not the delay in fielding the system would be acceptable would be a function of the predicted threat. Intuitively, it also seems logical to assume that stockpiling a few components would be significantly cheaper than building entire weapon systems that may never be needed.

Increased Reliance on Government/Commercial Integration

One of the most promising areas where production restart could be significantly enhanced is through increased government/commercial integration. The potential benefits of

utilizing existing commercial production lines to supply military components/subsystems, either directly or with some modification, is mind boggling. Not only would government/commercial integration aid the defense industrial base, it would also lead to greater economies of scale and subsequently, lower the cost of weapon systems. Of course there will always be some defense unique technologies and systems that have no commercial application (ie. MX missile, M-1 tank, stealth technology). But as Jeff Bingaman, Jacques Gansler and Robert Kupperman point out in their report of the Center for Strategic and International Studies (CSIS) Steering Committee on Security and Technology:

> At the same time, the materials, components and subsystems that make up those systems often have commercial counterparts that are (1) less costly (2) equal to, and in some cases, more advanced than their defense equivalents, and (3) capable of satisfying similar environmental conditions (CSIS, xii).

Refer to the Appendix, Table 5, for a list showing the considerable agreement between civil and military critical technologies. While this area is certainly not a panacea to cure all aspects of the restart problem, it would certainly aid immensely.

Barriers, Barriers and More Barriers: Unfortunately, for a number of reasons, there are many barriers within the U.S. that constrain the desired integration. The four main barriers identified by the CSIS are:

1) Accounting Requirements and Audits
2) Military Specifications and Standards
3) Technical Data Rights
4) Unique Contract Requirements

The key point to glean from this section is that the greatest impediment to government/commercial integration is not dissimilar technologies or products but rather the non-value added bureaucracy created in government acquisition. If the above barriers are removed, great progress can be made in government/commercial integration which will directly impact the speed of production restart.

Increase Use of Lean Production Techniques

The U.S. is currently in a "catch-up" mode with the rest of the world in terms of productivity improvement. The MIT commission on productivity reports:

> The industry studies reveal two main elements of past practice that are impeding progress today. First is the reliance on mass production of standardized commodity goods...The future of American industry will of necessity lie in specialized, high quality products (MIT 46,130).

Peter Drucker addresses this issue when he writes, "Today's factory is a battleship. The plant of 1999 will be a "flotilla", consisting of modules centered either around a stage in the production process or around a number of closely related operations" (Drucker 98). The move is already afoot in companies like Caterpillar Tractor and Ford Motor Company. The concept of lean production has many facets and has been defined in many ways. I believe there are four interrelated general principles that apply:

Empowering the Workforce: The recent emphasis on Total Quality Management has put a premium on unleashing the potential of the American worker. Concepts such as teamwork, ownership and

participative management can have a dramatic impact on the productivity of the workplace. Although conventional wisdom places more importance on automation, maximizing the effectiveness of human resources is just as important, if not more important. This point is underscored in The Machine That Changed the World where the authors state, "...we've devised the simple axiom that lean organization must come before high-tech process automation if a company is to gain the full benefit" (MIT 94).

Automation: Automation affords many advantages to the workplace: productivity improvement, quality, flexibility, customization and responsiveness. While automation takes many forms, a good example of automation that would be of great benefit to production restart is the use of Flexible Manufacturing Systems (FMS). While the term is used in many contexts, it is essentially "...a self-contained grouping of machinery--machine tools, robots, coordinate measuring machines, or whatever--that can perform all the operations required in the manufacture of a number of parts with similar processing requirements" (Young 8). The benefits to the production restart problem are obvious--a line running printed wiring boards for car radios one day could be running printed wiring boards for fighter aircraft or tanks the next.

Flexible Computer Integrated Manufacturing (FCIM): FCIM is the linchpin that ties the various elements of lean production together. To be successful, a manufacturing operation must be

conceptualized and then implemented as a system. Typical elements that must be integrated include Management Information Systems, Computer Aided Design/Computer Integrated Manufacturing systems, Manufacturing Process Plans, Shop Floor Control systems and individual machine tool programs. FCIM contributes to production restart by offering complete digitized documentation and a significantly improved response time to changes and/or problems on the line.

Exploiting Time: As companies search for ways to improve competitiveness in the new global market, time is becoming the latest differentiator. George Stalk states, "As a strategic weapon, time is the equivalent of money, productivity, quality, even innovation" (Stalk 41). This revolution is surfacing in concepts like Just-In-Time inventory, shortened product development times, elimination of Work-In-Process, and the focus on continuous process improvement.

The advantages these concepts of lean production bring to the factory all have application to successfully restarting a production line.

SUMMARY

The world is changing. When I began writing this paper in the Fall of 1992, most Americans didn't know where Somalia was and Bosnia was a distant place that certainly had nothing to do with the vital interests of the United States. Who knows what monumental events will occur in the months ahead. The

acquisition process, built around a strategy of Containment, must change to remain relevant in the "new world order". Primarily it must change to account for the shift from a national strategy of forces-in-being to a strategy of military potential. This change must include:

1) A More Flexible Acquisition Process
2) Fewer New Starts/More Existing Program Upgrades
3) Decrease in the Number of Production Programs
4) Increased Focus on the Ability to Reconstitute
5) Increased Emphasis on Four "...ilities"
6) Increased Reliance on Prototyping

Because of its importance, I spent a good deal of time discussing this last area--Prototyping. Prototyping can be the bridge that leads us from the "old" acquisition concept to the "new". But a prototype in and of itself is not the complete answer. A strategy must be devised to take a system that has been developed through low rate production and then "shelved", through production restart. Some practical recommendations were discussed:

1) Design Producibility In From the Start
2) Increase Manufacturing Technology and Process Investment
3) Develop "Smart" Shutdown Technologies
4) Develop a Long Lead Procurement Strategy
5) Increase Reliance on Government/Commercial Integration
6) Increase Use of Lean Production Techniques

The road ahead will not be easy--change never is. But applying the concepts presented in this paper will ensure our nation will be prepared to remain the leader of the "new world order".

WORKS CITED

Aspin, Les. "Tomorrow's Defense from Today's Industrial Base: Finding the Right Resource Strategy for a New Era." Speech by Chairman, HASC 12 Feb 92

Center for Strategic and International Studies (CSIS) Steering Committee on Security and Technology. Integrating Commercial and Military Technologies for National Strength. Mar 91.

Cochrane, Charles B. "DOD's New Acquisition Approach, Myth or Reality?" Program Manager Jul/Aug 92: 38-46

Congressional Research Service. Defense Reconstitution: Strategic Context and Implementation. Nov 92.

Drucker, Peter F. "The Emerging Theory of Manufacturing." Harvard Business Review May/Jun 90: 94-102

Gold, Ted and Rich Wagner. "Long Shadows and Virtual Swords: Managing Defense Resources In the Changing Sec. Environment." Amer Assoc for Adv of Sci & Int'l Sec Jun 90

IDA Paper P-2444. The Future of Military R&D: Towards A Flexible Acquisition Strategy. Jul 90

Industrial College of the Armed Forces. "National Security Emergency Preparedness: Mobilization Policy Review." ICAF Mobilization: Tab M-B 1 Feb 90

Kissinger, Henry. "What Kind of New World Order?" Wash Post 3 Dec 91: A21

MIT Commission on Industrial Productivity. Made in America New York: HarperCollins, 1990.

MIT International Motor Vehicle Program. The Machine That Changed the World New York: HarperCollins, 1990.

Nye, Joseph S., Jr. "What New World Order?" Foreign Affairs Spring 1992: 83-96

Oberdorfer, Don. "Bush's Talk of a New World Order." Wash Post 26 May 91: A36

RAND. Personal interview with Mr. John Birkler concerning DRAFT report WD-6820-ACQ. Mar 93.

Stalk, George Jr. "Time--The next Source of Competitive Advantage." Harvard Business Review Jul/Aug 88: 41-51

U.S. Congress, Office of Tech Assessment. Building Future Security: Strategies for Restructuring the Defense Technology and Industrial Base. OTA-ISC-530 Wash D.C.: GPO Jun 92

U.S. Congress, Office of Tech Assessment. Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base. OTA-ISC-500 Wash D.C.: GPO Jul 91

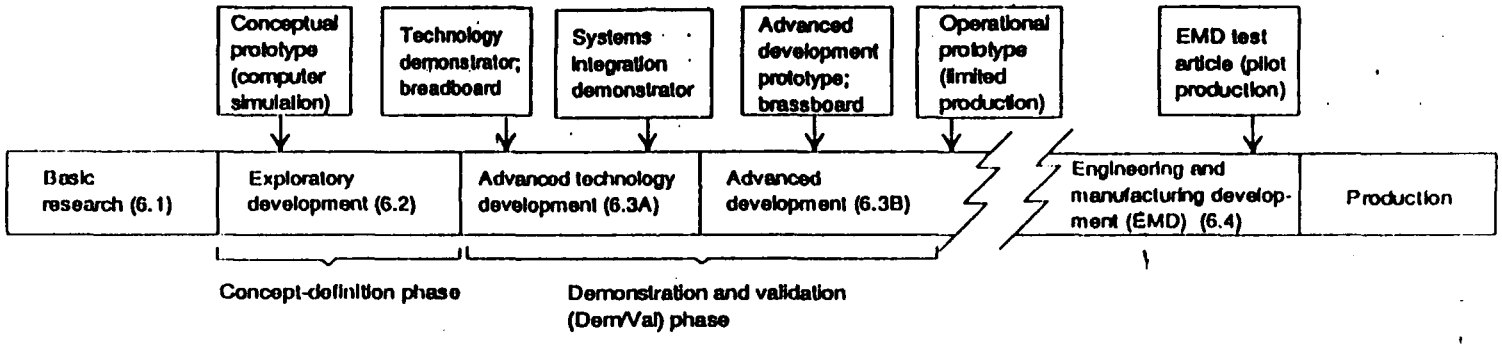
Yockey, Don. Memorandum, Under Secretary of Defense for Acquisition, Subj: Defense Acquisition 20 May 92

Young, Clifford and Alice Greene. "Flexible Manufacturing Systems." AMA Management Briefing New York: 1986

APPENDIX

TABLE 1

The Prototyping Spectrum



SOURCE: Office of Technology Assessment, 1992.

TABLE 2

Acquisition Program vs. ATD

	Acquisition Program	ATD
Rules	DoDD 5000.1/DoDI 5000.2	DTB by DDR&E
Role of User	Max Involvement	Some Involvement
Requirement	MNS/ORD	Not Required
Oversight	DAB/USD(A)/CAE	DTB/DDR&E/CAE
Funding	Fully FYDP Funded	RDT&E Only
ACAT	I, II, III, IV	Not ACAT Effort
Hardware/ Software	System/Subsystem Prototypes	Advanced Technology Demonstrators
Testing	Extensive DT & OT	Mostly DT, some OT

ATD: Advanced Technology Development
MNS: Mission Need Statement
ORD: Operational Requirements Document
DAB: Defense Acquisition Board
DTB: Defense Technology Board
CAE: Component Acquisition Executive
FYDP: Future Years Defense Program
ACAT: Acquisition Category
DT: Development Testing
OT: Operational Testing

Source: Cochrane, Program Manager, Jul/Aug 92

TABLE 3

STATEMENTS ON PROTOTYPING

President's Blue Ribbon Commission On Defense Management: 1986

We recommend a high priority on building and testing prototype systems to demonstrate that new technology can substantially improve military capability, and to provide a basis for realistic cost estimates prior to a Full Scale Development decision. Operational testing should begin early in Advanced Development, using prototype hardware. The early phase of R&D should employ extensive informal competition and use streamlined procurement processes.

Defense Management Report: 1989

In particular, these policies will dictate that the schedules and management plans for major programs:

- Support the building and testing of system and critical subsystem prototypes, the use of systems engineering and the validation of manufacturing processes as early as possible and certainly well prior to the commencement of high rate production.
- Provide for early test and evaluation of prototype hardware to prove concept, performance and suitability in realistic operational environments.

Long Shadows and Virtual Swords: Managing Defense Resources In the Changing Security Environment: June 1990

A "virtual deployment" is a capability brought to within some time before actual deployment...and then put on "hold" to be maintained at that (or a time-varying) state of future deployability, introducing new technology as it becomes available....Production of prototypes would also play an important role in order to learn about manufacturing problems and/or provide some systems to the users.

The Future of Military R&D: Towards a Flexible Acquisition Strategy IDA Paper P-2444 July 1990

III. The Key Elements of a Flexible Acquisition Strategy

D. Increased Use of Prototyping

Recommendation 4: Increase the use of prototyping. Prototyping is broadly defined here to include technology demonstrations (including ATDs), product improvement prototypes and other efforts shortof, as well as including, pre-production prototypes

DODI 5000.2: February 1991

Part 3, Para 3.d.(2):
Prototyping, testing and early operational assessment of critical systems, subsystems and components will be emphasized (see Section 5-D). This is essential to:
(a) Identifying and reducing risk, and
(b) Assessing if the most promising design approach(es) will operate in the intended operational environment including both people and conditions
Part5, Section D:
-Prototyping. Prototyping will be a major element of Phase I, Demonstration and Validation

Redesigning Defense, Office of Technology Assessment, July 1991

p. 94 A key element of the future DTIB will be a continuous design and prototyping capability that can operate with reduced R&D spending and in the face of curtailed production.
p.95 Figure 5-3 Dual-Track Prototyping Strategy (not included)

Tomorrow's Defense From Today's Industrial Base
Rep. Les Aspin, 12 Feb 92

p. 15 3) Rollover-Plus
We believe that a "rollover-plus" strategy can contribute significantly to our ability to accomplish just that. In essence, we mean a process of continuous prototyping and development of manufacturing technologies.

Building Future Security, Office of Technology Assessment, Jun 92

Chapter 3, Prototyping-Plus, p. 51-75
One approach to this problem, called "Prototyping-Plus", would involve the continuous development of prototypes and, in selected cases, limited production for operational and field testing.

TABLE 4

ENGINEERING	TOOLING/MANUFACTURING	MATERIAL	QUALITY	OTHER
R Drawings	R$ Tools "one each"	R Bill of Materials	R Test Procedures	O Key Personnel List
R Test Procedures	O Job Description	R Supplier List	R Qualification Test Data	O Lessons Learned
R Configuration Documentation	- Videos, etc.	R Alternate Suppliers (Qualified)	R Production Inspection Records	- Training
O Updated Drawings	R Tool Designs	O$ Long Lead Materials	R Source Inspection Records	R Contracts & Amendments
R Software Source Code Mission Equipment Test Equipment	R Special Test Equipment	R Critical Materials List plus sources	O Quality Defect Records	R Auditable Cost Records
O$ Mockups	R$ Master Gauges	R Make/Buy Plans		O Cost Accounting Disclosure Statement
O$ Test Articles	R NC Source Data			O$ Facilities
O$ Iron Bird	R Mfg. Plans/Schedules			
O$ System Integration Lab	O$ Machine Accessories			
R Qualification Test Data	R$ Unique Machine Tools			
R Engineering Analyses stress, loads, drag Flying qualities, Propulsion, etc.	R Indentured Parts List			
	R Detailed Build Plans			
	O Org. Chart w/Crew Sizes			

R = Required, even if low probability of restart
O = Optional, nice to have
$ = Relative storage cost is high

Note that many of the above items are facility specific and lose some value if another facility will be used

Source: RAND

Useful Items for Production RESTART